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REPORT OF THE MIDWEST CONFERENCE ON ARTICULATION IN THE SCIENCES BETWEEN JUNIOR COLLEGES AND 4-YEAR COLLEGES AND UNIVERSITIES, DES MOINES, IOWA, SEPTEMBER 30-OCTOBER 1, 1966.

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Speeches, speech summaries , and sectional meeting notes from the Midwest Conference on Articulation in the Sciences Between Junior Colleges and Four Year Colleges and Universities are included in this report. The speeches treat such topics as (1) differences and similarities between junior colleges, four year colleges, and universities, (2) problems of course equivalence and transfer between schools, (3) educational objectives in higher education, (4) student problems in college transfer, (5) need for communication to facilitate science program articulation, (6) sources of articulation problems, (7) coping with the knowledge explosion, (8) problems in higher education, and (9) activities of the Commission on Undergraduate Education in the Biological Sciences (CUEBS). Summations of the section meeting include notes on such topics as (1) t aching the scientific enterprise, (2) the nature of science, (3) individualized teaching, (4) team teaching, (5) laboratory teaching, (6) use of the library in instruction, (7) integrated science courses, and (8) courses for majors and nonmajors. (RS)

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REPORT OF THE MIDWEST CONFERENCE ON ARTICULATION IN THE SCIENCES

Between Junior Colleges and 4-Year Colleges and Universities

September 30 - October 1, 1966

Hotel Kirkwood
Des Moines, Iowa

Sponsored by

THE NATIONAL SCIENCE TEACHERS ASSOCIATION
1201 Sixteenth Street, N. W.
Washington, D. C. 20036

and

THE IOWA ACADEMY OF SCIENCE

T-A-B-L-E O-F C-O-N-T-E-N-T-S

The Program	1-2
First General Session	3-11
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Fourth General Session	45-49
Conference Participants	50-55

FRIDAY, SEPTEMBER 30, 1966

8:30 - 9:30 REGISTRATION—Hotel Lobby

1ST GENERAL SESSION
Pioneer Room

9:30-10:45 Dr. Leland P. Johnson, Presiding
Drake University

"Attempt The Future's Portal"
—Robert O. Birkhimer
Community College Division
Dept. of Public Instruction

"The State of Science Teaching"
—Roger Volker
Webster City Junior College

10:45-11:00 Coffee Break

2ND GENERAL SESSION
Pioneer Room

11:00-12:00 Dr. John Chellevold, Presiding
Wartburg College

"New Differentials and Integrals in Science"
Science" —Dr. R. Ray Haun
Drake University

12:00 - 1:00 Luncheon—Orchard and Arbor Rooms

3RD GENERAL SESSION
Pioneer Room

1:15 - 2:30 Dr. Robert Yager, Presiding
University of Iowa

Panel Discussion — Problems of Junior College Students Transferring to a 4-Year College

Dr. Clifford McCollum, Head of Science, State College of Iowa

Dr. Chalmer Roy, Dean Sciences and Humanities, Iowa State University

Dr. Richard Bovbjerg, Biological Sciences, University of Iowa

Dr. James Divelbiss, Biological Sciences, Westmar College

2:45 - 4:15 Section Meetings:

1. **Science Defined: The Methods, Teaching the Scientific Enterprise to Freshmen and Sophomores.**

   A. Capital Room
   Dr. Delma Harding, Zoology, Chmn.
   Iowa State University
   Thomas Rider, Chemistry, Recorder
   Grandview College, Des Moines

   B. Marquette Room
   Louis Bosveld, Physical Sciences, Chmn.
   Mason City Community College
   Dr. E. Russell TePaske, Biology, Recorder
   State College of Iowa

2. **Science Integrated: The Courses, Common Denominators in the Sciences.**

   A. Kirkwood Room
   Dr. Leland Wilson, Physical Sciences, Chmn.
   State College of Iowa
   Marvin P. Jessen, Biology, Recorder
   Grandview College, Des Moines

   B. West Room
   Dr. Donald M. Huffman, Botany, Chmn.
   Central College, Pella
   William Azbell, Physical Sciences, Recorder
   Wartburg College, Waverly

3. **Science Diversified; The Curriculum, Teaching Science for Science and Non-science Majors.**

   A. Garden Room
   Dr. Emil Miller, Physics, Chmn.
   Luther College, Decorah
   Howard Bath, Biology, Recorder
   Fort Dodge Community College

   B. Colonial Room
   William Schmidt, Biology, Chmn.
   Ellsworth College, Iowa Falls
   Harvey Lundy, Physics, Recorder
   Estherville Community College

4. **Applied Science or Academic Science: Who Should Teach It?**

   A. Iowa Room
   Dr. Sherwood Tuttle, Geology, Chmn.
   University of Iowa
   William Pecha, Chemistry, Recorder
   Muscatine Community College

   B. Arbor Room
   John Page, Biology, Chmn.
   Mason City Community College
   Dr. Donald Biggs, Geology, Recorder
   Iowa State University

6:30 Banquet—Pioneer Room
Greetings from NSTA—Dr. Albert F. Eiss
National Science Teachers Association

"Post High School Education in Iowa"
—Dr. J. W. Maucker, President
State College of Iowa

SATURDAY, OCTOBER 1, 1966

4TH GENERAL SESSION
Pioneer Room

8:45 - 9:45 David Fagle, Presiding
President, Iowa Science Teacher's Section
Iowa Academy of Science

"The Activities of the Commission on Undergraduate Education in the Biological Sciences"
Dr. Ted Andrews, Associate Director CUEBS

9:45-10:15 Coffee Break

10:15-12:00 Section meetings (same as Friday p.m.)
The Saturday morning section meetings will be structured the same as the Friday afternoon meetings, and will meet in the same rooms.

12:00 Luncheon—Orchard and Arbor Rooms

"College Science in 1980"
—Dr. Richard M. Harbeck
Research Coordinator, Bureau of Research,
Dept. of Health, Education, and Welfare.

Conference adjourns after lunch, but many of the Conference speakers will remain for informal conversation.

We invite you to meet them.

FIRST GENERAL SESSION

ATTEMPT THE FUTURE'S PORTAL

Robert O. Birkhimer
Iowa Department of Public Instruction

Summary of Remarks:

1. As community colleges and small colleges increase in student enrollment, each will be better able to prepare students more specifically for transfer. Science sections with a "difference" can be afforded.

2. The universities and four-year colleges must, themselves, however, bend somewhat in the nature, extent, and specialization of science offerings in their lower divisions if they are to benefit from the blessings of capable transfer students.

3. The past has shown that these blessings have not been wholly unmixed blessings.

4. The "second track" or "second curriculum" for community college students not well prepared in high school for majoring in college science, has brought its share of problems in articulation.

5. The train of prerequisities, set (and fixed) in four-year institutions, often occupies the whole four-year track (the whole railway) of science majors, so that transfer students can get railroaded into strange sidings.

6. Articulation efforts at the college-administrator level and at the science-teacher level will not count for much, unless understood and applied at the college-dean level and the department-head level.

7. Comprehensiveness of community colleges is a rapidly developing phenomenon. It brings a whole peculiar set of articulation problems.

8. Some of these articulation problems are internal within the community college:

   .. Shall applied science be taught by the science teacher, or by the vocational teacher?
   .. How specific shall its content be?
   .. Can it transfer from one technology to another?
   .. Or from a vocational program to a technical program?
   .. Or vice versa?

9. Some are inter-institutional problems:

   .. What shall be labeled "credit"?
   .. Which courses should be transferable?
   .. Which should not?
   .. Who determines the difference?
   .. How can a registrar or a dean or a director tell by looking?

10. Some are interstate problems:

    .. Shall there be an attempt to correlate, coordinate, articulate?
    .. How does electronics technology look in Cedar Rapids as compared to that at Chicago Southeast? Or Cuyahoga? Or Miami-Dade? Or Niagara Falls?

11. The need for articulation increases as mobility increases.

12. Yet individuality and diversity are the life blood of higher institutions.

13. Spokesmen for community colleges have hailed diversity as an asset and a prerogative.

14. The magnitude of the problem may be assessed if we posit these facts: Articulation in higher education must accomplish a compatibility of human learnings so as to allow an optimal transition of an increasingly wide variation of students from an increasingly ubiquitous set of increasingly comprehensive colleges to an increasing number of increasingly complex higher institutions without destroying either the chartered prerogatives of institutions or the students' right to equality of opportunity.

15. E pluribus unum? Or caveat empor?

THE STATE OF SCIENCE TEACHING

Roger Volker

Webster City Junior College

Why we're here. This conference began about a year ago, at a meeting of the Iowa Science Teachers Association Executive Committee. During that meeting some of us who teach in junior colleges began exchanging comments on the science courses we teach. Questions came up like, "Which text are you using?" "How many hours of credit does your biology course carry?" or "How much math do your students need before they take physics?" Several of us began to realize that there was a need to explore and articulate ideas among ourselves, in a kind of "horizontal" framework from one junior college to the next. And, since many of our students transferred to four-year colleges and universities here in Iowa to finish their education, there would be value in a "vertical" articulation between junior colleges and the four-year schools.

We discussed the idea with some of the members of the Iowa Academy of Science, and the result was an organizational meeting for this conference last March, here in Des Moines. More than a dozen of us got together to structure the conference. Our main concern was that it provided maximum interchange of ideas; we knew we would not be able to recommend mandates or effect major changes in the science teaching in Iowa. But we wanted to make a start at bringing together the science instructors for mutual "brain picking." We hoped for small discussion groups, and chose a chairman-recorder team for each group, consisting of a four-year college instructor and a junior college instructor.

Points of comparison. There is a lot of talk today about the value of small versus large schools. If we polled this group right now, we would find a sharp division between those believing that a four-year education at a larger college or university is superior, and those firm believers in an education from a smaller school. Likewise, we would find disagreement between those who think the first two years should be taken at a junior college, and those who think the first two years should begin at a four-year school.

This controversy has received national attention. The March 1966 issue of Atlantic Monthly magazine carried a lively discussion between Dr. Allen Wallis, president of the University of Rochester in New York, and Dr. Howard Lowry, president of the College of Wooster in Ohio. Dr. Wallis defended the large school. He said:

> "The issue is whether the independent . . .
>
> college, isolated from graduate work and
>
> research, can continue to attract and hold
>
> faculty to top quality who can speak to the

> dynamic spirit of man';and whether able, well-prepared, and strongly motivated students can attain their fullest development within a four-year curriculum. Should not most such students pursue at least one subject beyond the normal undergraduate level, so that 'the four years can be richer and more significant?'"

In defense, Dr. Lowry said:

> " . . . the small college can get out of ruts more quickly, experiment freely, and provide teachers who <u>teach</u>. They must resist the attempts made to turn them into mere coaching schools for a given . . . department, at the expense of a liberal education. The best deans are realizing and saying that the greatest gift a college can send the graduate school is a liberally educated person."

Comments like these disturb those of us who teach in the junior colleges. What do our "big brothers" in the four-year colleges and universities think of our programs? Do they really believe that our introductory courses in science are solid and significant? Do the college professors--the PhD's--look at us with Master's degrees as people doing remedial work with second class students--with students who "couldn't get in the bigger schools?"

<u>Dichotomies in higher education</u>. In one sense there is a difference between the whole <u>modus operandi</u> of the junior college system and the four-year college system here in Iowa. Some specific dichotomies are listed below:

1. Scope of Curriculum. The junior colleges offer fewer courses, not only from one field to another, but within a single area. Some of our larger universities teach several levels, or "types" of freshman chemistry. Most junior colleges have one course in freshman chemistry.

2. College atmosphere. Without a true campus and with many of the students living at home, the activities that provide the well-rounded education of the larger four-year schools are absent.

3. Research and publishing. Without graduate departments, extensive facilities and equipment, and with greater teaching loads, almost no research is done in the junior colleges. It is somewhat unfortunate, but that is the present situation. Without active research there is little published material from the junior college faculties.

4. One-man departments. Because of small faculties, no upperclassmen, and small enrollments, many of the departments in science consist of only one or two faculty members.

5. Grading criteria. We have, in general, more underachievers in junior college than in the four-year schools. Because of this, our grading "curves" tend to be different from those for the same course at a larger institution.

6. Non-specializing students. The stimulation of working with students who plan to major in your own field of science is lost in the junior college. Without upper level courses we do not often get the students who show specialized interests.

7. "Soft" courses. Do the four-year instructors believe that our junior college offerings in chemistry, physics, general mathematics, calculus, biology, botany, and zoology are as comprehensive as those offered in the larger schools? Or do they feel that the students are getting a superficial treatment of the subject--a soft course?

8. Limited facilities. Because of our small departments, we often find certain kinds of equipment lacking. In larger institutions it is possible to borrow between departments, but there are no "other departments" in the junior college.

9. We educate "all students." Even though our "open door" policy is that the door swings both ways, we still feel morally bound to try more intensively to help the faltering student. It doesn't seem any easier than it would be at a larger school, because of the heavier teaching load of the junior college instructor. But we try to make the attempt at helping individual students.

10. Work load. Professors in colleges and universities teach one or two 3-hour courses, but junior college instructors may teach up to 15 credit-hours, with 20 or more contact hours.

11. Mutual understanding. Perhaps the biggest difference between junior college instructors and four-year instructors is in the understanding of each other's operation. Since the junior college instructors have been through graduate school and worked closely with a major professor, they have some understanding of the operation of a college science department. But the

professor of a science in college may never have taught in a junior college, or attended one.

Some similarities. Actually, the instructors in both schools aren't as different as one might believe. According to the North Central Association of Colleges and Secondary Schools, the ages and salaries and often the educational background of junior college and four-year instructors is quite similar. The Association states:

> 70 percent of all new instructors are less
>
> than 40 years old.
>
> The same percentage of each is in the 40-50
>
> age group.
>
> The median age is 31 years.
>
> About one-half have taught in high school.

Practically all of the junior college instructors have Master's degrees, but there are very few PhD's. Of 22,000 instructors in 400 junior colleges, the salary was an average $8000, ranging from $3000 to $15,000.

The number of junior college instructors has increased about 50 percent in the past two years. But of course a new junior college has opened every week in the past 12 months.

Our philosophy of education seems to be to try to give everyone a chance for an education. Dr. David Henry, head of the University of Illinois, in a recent issue of U. S. News and World Report, stated that the junior colleges should:

1. Offer the academic equivalent of the first two years of liberal arts and sciences for the students who will transfer to the universities.

2. Offer general education for students who do not go beyond the junior college.

3. Offer technical education for the students who want post-high school, vocational, or technical training.

4. Offer adult education adapted to the needs and interests of the community.

Specific problems to attack here and now. With this background in mind, in which we have characterized the junior college instructor and the setting in which he works, let us turn to specific questions that we hope to find answers to in this conference.

1. Should instructors in technical and vocational programs, which are currently being set up in the new area schools, teach their own "brand" of science, or should science for technical and vocational students be taught by a science instructor?

2. Is a core science program valid for the smaller junior colleges and four-year colleges?

3. Would some sort of generalized test in science help in placing junior college graduates who transfer to four-year schools? How about trading final exams among instructors?

4. Are we gravitating toward uniformity in course content and course sequence in Iowa?

5. How can we implement articulation between the technical and vocational programs, and the pure academic programs?

6. How can the science curriculum be made more versatile to take care of the increasing diversity of students?

7. How well prepared are junior college instructors to teach science?

8. What should we teach students in science, so that they can understand what scientists are doing and how they solve problems?

9. Does the spirit of inquiry fit into the college sciences? How do you teach inquiry to college freshmen?

10. How can instruction in science equip students to communicate in other subject matter areas?

Some of the most conforting words for those of us who teach in junior colleges were spoken by Dr. Glenn Leggett, at his installation as president of Grinnell College last April. He said:

> "One hears now the pronouncement from universities that the small college is dying for lack of resources and competent faculty . . . that community colleges are really remedial institutions. Bigness and smallness and level of operation are not virtues in themselves. What counts is the way they are used, honestly, to do that job they are designed to do, whether it be to teach undergraduates or graduates, or to conduct research, or to serve the local or state or national community, or some combination of several of these purposes."

We at the junior college cannot operate in a vacuum, divorced from the activities of the four-year schools. We certainly don't want to end up like the railroads. We want to sell "total education," not specialty education. If the railroads had been selling transportation instead of railroading, they'd be running the airlines today.

Working together, sharing ideas, discussing our common problems, we hope to emerge from this conference with greater understanding and respect for each other's position and with a more unified approach to the important job of teaching science.

SECOND GENERAL SESSION

NEW DIFFERENTIALS AND INTEGRALS IN SCIENCE

R. Ray Haun

Drake University

Above all the forms of life on the earth stands man. Make whatever theological interpretations of it you please, there is general agreement that as an organism man is superior. One of the ways in which man is superior is that he has developed language, both spoken and written, and as a consequence he is able to store up in words the achievements of time. Each generation is able to acquire the achievements of past times and pass them on to the next generation; hopefully the next generation improves and increases the accumulations and passes the total on to the next generation.

These accumulations we call knowledge, and we, as teachers, have assumed a major role in the transfer process. Many illustrations have been used to emphasize the importance of this transmittal knowledge and what would be the consequences if all of a sudden we could not or would not transmit what we know about some area, say electricity, on to the next generation and our knowledge had to be reacquired by the ab initio process.

I have tried to think how one can put any kind of measure on this huge bulk of accumulated knowledge. I thought of the books that contain the knowledge in written form; so I turned to our references to see how many there are in our largest library, the Library of Congress. Forty years ago there were 3 million books and pamphlets in the Library of Congress. Now there are 14 or 15 million. The Crerar Science Library has over a million. Of course, there is a lot of duplication; suppose 9/10 of it is duplication, there would still be 1-1/2 million books. Or if 99 percent is duplication there are still 150,000 books of knowledge that man has accumulated. And it is not worth a thing in the books. It has to get into the minds of people. This is what makes our teaching and learning important and imperative.

Let's look at that knowledge that we are teaching. In the Colonial days when colleges were first introduced into this country the curriculum was rather standard in all of them; Latin, Greek, Philosophy, and Mathematics. Basing his information on a two-volume book written in 1800 by Rev. Samuel Miller, entitled A Retrospect of the 18th. Century, Theodore Hornberger says that there were then 27 colleges. The courses had expanded to 26 in order to include more foreign lauguages, law, history, and about a dozen courses in various aspects of medicine and related sciences.

Recently I took the time to count just the science courses, pure and applied, offered by an eastern university. There were over a thousand with distribution as follows:

Chemistry 60; physics 65; mathematics 80; biology 25;
Geology and geophysics 35; meteorology 20.

Total in pure science	300
In addition there were in engineering and applied science	500
and in medicine	200

I did not count the other areas of knowledge. I am only interested in SCIENCE.

As large as the problem of transfer is with the bulk of knowledge, which we have now accumulated, the overall picture becomes still more complicated when we consider the rate at which knowledge is growing. Again I will limit myself to the field of science with which I am most familiar. The American Chemical Society publishes a journal called Chemical Abstracts. This journal issues twice a month a magazine containing paragraphs of approximately 50 to 200 word abstracts of articles appearing in other magazines. According to its recent report, Chemical Abstracts covers 5,236 periodicals. I estimate the number of articles covered would be about 5,000 every two weeks or somewhere around 150,000 differentials of knowledge every year. Some months ago the American Chemical Society news magazine included a headline story saying that Chemical Abstracts had just published its 3,000,000th abstract. The abstracts began almost at the turn of the century; the first million was reached after 32 years, the second million 17 years later, the third million in only 8 years.

As you undoubtedly know, all major disciplines have now adopted this pattern of abstracts for the articles that are being produced in their respective fields. Last year biological abstracts numbered 110,000 items; physics, 35,000; and I was amazed to find the special nuclear science abstracts had 25,000 items last year. To these should be added the other disciplines, astronomy, geology, and the applied sciences, medicine, pharmacy and the various engineering and technology magazines. I gave up trying to get figures on all of them, but I quickly estimate over a half a million a year; and I believe there would be less duplication in these than in the books we have in our libraries.

When I suggested the title of "New Differentials," I thought I would pick out some items from the current magazines to illustrate how small, even though important, most of them seem to be when one thinks in terms of the huge bulk of knowledge that man has already acquired. I listed:

Polarity of Ice Surfaces
Resistivities, Gallium arsenide
Proline, conversion in collagen
Absorption spectra of minor bases
Metabolic Inhibitors

Countercurrent Fractioners
Krebs Cycle, reversal by photosynthetic bacterium
Hydrazine, fuel cells
Computer graded examinations

and there I stopped, for I soon found myself in the mental and emotional condition of the station agent in the little story "Pigs is Pigs," by Ellis Parker Butler. If you have never read it to your children, I suggest you read it to yourself. If you do not know the story, it is about an express agent, Mike Flannery, who had trouble delivering a consignment of two guinea pigs to Mister Morehouse because his rate book said the rate for pets was 25¢ and the rate for pigs was 30¢; it also said that if there was any doubt about a rate, he should charge the higher one, and if the customer complained, he should then take up the matter of a refund. Flannery tried to collect 30¢ and Mr. Morehouse refused to take the guinea pigs, and the long, cumbersome wheels of a huge enterprise are set in motion, going through all the departments and eventually writing for an opinion to the scientist retained by the company who happens at that time to be on an African expedition. So time marches on and Flannery, under protest, is told to feed and care for the multiplying guinea pigs, which eventually fill all the space in the express office and require extra help to take care of them. Finally, he is told to collect fifty cents and get rid of them, so delightedly, he goes to tell Mr. Morehouse only to find that Mr. Morehouse has moved out of town. Then Flannery, following another directive in his book, ships them back under great protest as they began to stream into the city receiving station. But from the experience he came to one conclusion. From then on "pigs is pets; cows is pets; horses is pets; and lions and tigers is pets; and the rate is 25¢ on all of them." He breathed one final observation to himself. He was glad them dago pigs were not elephants.

What are we going to do with all these little guinea pigs or differentials of knowledge? You cannot ship them back, and if we are teachers we cannot forget them nor neglect them. Some consequences have already occurred, and there are others on the horizon.

One of the most obvious consequences is that it has led to specialization. This needs little discussion. It is implied in the summary of courses above. It is evident when we consider any summary of occupations. An occupational index produced by a Federal Agency just at the close of World War II listed 40,000 kinds of jobs in this country, and I am sure the number is much greater now. We do not see how, and cannot imagine that there is any way to escape specialization for ourselves or for our students. And yet, the more we specialize, the more impossible we find the situation becomes. There is no nice little cave, island, planet or star to which we can go and find nothing but the rare earths, or the radio-active isotopes, or homozygotes or molecular genetics. We cannot even find a box that has nothing but physics in it. I am not trying to be facetious. Specialization is necessary, but it presents serious problems, particularly for those who are concerned about preparation for living in a specialized society. The natural world does not operate in compartments, but as a whole with interconnections and interrelationships that tie it all together, and man must struggle to see this structure of interrelationships if he is to understand any part of it. Tennyson put it clearly and beautifully

in the words:

> Flower in the crannied wall
> I pluck you out of the crannies.
> I hold you here, root and all, in my hand.
>
> Little Flower - but if I could understand
> What you are, root and all, and all in all
> I should know what God and man is.

This leads to the second part of my title, "New Integrals in Science." While we have been producing new differentials, we have at the same time been integrating some of the old and some of the new into larger concepts and conceptual schemes. Some of great significance since the early part of this century are the integrations in the areas of molecules, atoms, galaxies, genetics, paleontology, thermodynamics, and electronics to mention a few. The differentials for these often go back several centuries and the first integrations for over a century; for Dalton and Hutton both produced major contributions about 1800 and Claussius, Carnot, and Mendel in the early and middle 1800's.

While the selection of the most significant differentials in the current abstracts was difficult, illustrations of what I mean by new integrals was much easier. I jotted down the following: (1) radio-astronomy, (2) solid state, (3) molecular biology, (4) superconductors, (5) semiconductors, (6) lasers, (7) crystal surfaces, (8) ecosystems, (9) biosynthesis, (10) radio-active isotopes, (11) organic spectra, (12) bioenergetics, (13) molecular genetics, (14) photo-synthesis, (15) viruses, (16) organic spectra, (17) carbanion chemistry, (18) plastics, (19) high-temperature plasmas, (20) stocchastic processes, (21) mossbauer effect, (22) computers, (23) cybernetics, (24) artificial hearts and other organs, (25) space flight, (26) hypersonic flow, and (27) preservation of human bodies by freezing.

Some of those are more theoretical, some are practical and technical developments. Some are older but new is being added. Some are new, but integrations are coming rapidly. One of my references said that the first paper on lasers appeared in 1960, and another said the first transistor radios were produced in 1955. I am sure the list could be extended to hundreds, maybe a thousand; rather than continue it, I would like to suggest some of the ways that I think these developments affect our teaching and, in particular, the problems that arise as we go into the further discussions of this conference.

1. Desperately, we need to do still more integration of our knowledge; to find what is being referred to by many people as structure. Not so long ago, Gerald Holton had an article in Daedalus on the tree of knowledge in science in which he tried to show how limbs and branching have developed as what I have been calling today differentials and integrals have accumulated. More of this needs to be done.

The term structure was emphasized at a 10-day study conference in 1960 called by the National Academy of Sciences and supported by the National Science Foundation, the U. S. Office of Education, and other agencies to consider the fundamental processes involved in imparting to young students a sense of the substance and method of science. In his little book entitled The Process of Education, summarizing this conference, Jerome Bruner says in the chapter on structure, "the teaching and learning of structure, rather than the mastery of facts and techniques, is at the center of the classic problem of transfer."

Possibly out of this conference here could come a movement to more closely structure our scientific knowledge. I think that we are severally finding the need for using basic concepts in other disciplines than our own as is evidenced by such topics and courses as molecular biology, bio-chemistry, geo-chemistry, earth sciences, physics-chemistry courses. We see the need, too, as we examine each other's books' outlines and see some basic concepts of atoms, molecules, radiation, temperature and heat energy, radioactivity, fundamental measurements and often basic math and calculus taught in all of them. It is my own personal conviction that there are some very basic concepts that could be taught to all students in science under one fundamental structure, which would of course, be in accord with the conference idea reported by Bruner.

2. In the second place, or possibly first, we need to consider and discuss more the consequence of something we already know, which is, that we cannot teach everything man knows, not even all the science, in one course. And, unless or until we do find a trunk in our scientific knowledge and the first branches that logically develop out of it to teach first, we can expect to have different content and different emphasis in our beginning departmental courses. For mass education purposes, we should probably search for a common content at various age levels in each of our disciplines but in recognition of individuality, a term our Drake president emphasized in his convocation address the other day, we need to do something different. How much we can do in a mass education system is quite debatable in my opinion. But I hope that the development of larger and larger masses of students will not scare us into thinking we must all have the same uniforms in our teaching.

Many of us are perturbed by the fact that some students get blue, green, and yellow biology and some get chemical bonds or PSSC courses and others something else, and we probably should be perturbed. Nevertheless, these are basically new integrals in course construction and historically we have always had them. Let me illustrate.

The first year of my teaching, I found an old but large physics book, pre-1900, in the college library which contained some thirty-odd pages about films, soap bubbles, capillary phenomena, and surface tension. Now all that was essential in that book and more is contained in two or three pages as it is discussed under molecular forces, in the general physics text; one can, of course, make a lifetime

specialization out of it.

Let me give another illustration of our changing course contents in the past. When I taught at the University of Minnesota, the general chemistry text being used contained over a tousand pages. The other day, I looked the book over again carefully to see what was actually in it and found that less than a hundred pages, scattered throughout the book were related in any way to our present ideas of atomic structure. Now in at least some current general chemistry books of a little less than a thousand pages about a third of the books are devoted to structure of matter and quantum theory considerations. I am not objecting to it. I do it myself in my own teaching, although I sometimes wonder about the material which we thought was so important 25 years ago and which we now omit from our courses. However, the main point is that the development of new knowledge, differentials and integrals, makes us change our courses and we must expect it.

If we can do anything here in the sixties or again in the seventies to integrate our changing course content materials from one level to another, we ought to do it, for the sake of the masses of students; since it seems we must work with them in masses. But I think we all find that more important than the specific content details a student brings with him is <u>his</u> ability and enthusiasm for intellectual inquiry and <u>our</u> ability to assist him in his intellectual growth.

3. And that leads me to my third and final suggestion. <u>We, ourselves, need to learn more about the process of education</u>. There are differentials, and both old and new integrals about the learning process that as teachers we ought to know. I have referred to one of the conclusions of the recent study of a group of scientists and others as reported by Bruner in which they said that "teaching and learning of structure, rather than mastery of facts and techniques, is at the center of the classic problem of transfer." But how does one teach structure or how do we or our students learn structure in knowledge? I would hazard a guess that we would not find it as hard to teach structure as to teach or memorize facts if we worked at it a while. We are now trying some integrating seminars at the senior level or too often we are hiding behind a cloak in saying that this is something the student must do for himself. The Bruner report implies that learning to see structure comes first.

Another topic in the Bruner book, and it is evident that I am quite impressed by the book, is "readiness for learning." It seems to me that we have done very little on this point in teaching science. Just because some students can learn the calculus at the high school level is no guarantee that all students can learn it there or that this is the best time to teach it. Possibly the basic concepts of rates and summations should be taught earlier and the operational mechanics later. I do not know, and I have not found any reported investigation on the question.

We all know the psychologist stories about infants that are taught to swim, skate, or climb stairs; and their reports that, while it can be learned at early ages, the majority of children learn the same things more quickly and more effectively at a later age.

We are in a wave of introducing research at earlier and earlier ages. I believe in it, and I think I am doing it. But I have no assurance at all that I should be doing it at the expense of say, helping my students to build a scientific vocabulary. So far as I can find out and I have tried, we have made no studies of maturation in science and I am confident that there are some phases that can be taught earlier and others that can be learned more efficiently later.

Just one other aspect of the process of education, and this was also in the Bruner report, although I have talked about it many times before reading the book --learning and discovery by intuition. We all know the stories about Kekule and his smoke rings giving him suddenly the carbon ring idea and Pauling's sudden intuition about stranded chains of atoms in the huge protein molecules such as DNA and RNA; and with a little reflective thinking, we may realize that we all suddenly solve many of our scientific, teaching, and personal problems without using recognizable deductive, inductive, or any kind of reasoning. The question is how do we do it. The Bruner report says it is known that students learn by intuition and learn effectively. But how can you put them in a situation where their minds will work this way? Possibly it is by locking them up in a room with the things they need around them. Or putting a spring balance, some weights, and a ruler on a table and then telling them to discover the laws of elasticity. But can they learn to do it more effectively and more rapidly in some other situation? If so, how?

In summary, what is the process of education, and what are the ways in which humans learn and the ways in which we teach most effectively in science?

In the beginning, I tried to emphasize the importance of teaching. I thought I would close but I do not know if I should or not by just saying---Be a teacher.

When I put it down in my notes, I was reminded of an epigram that you probably heard long ago. The owner of the little department store in my home town had it on a placard above the big cash register in the center of the store where everybody had to go to complete their purchases, whether cash or charge. It read, "Man is made of dust. Dust settles. Be a man."

Be a teacher.

THIRD GENERAL SESSION

PROBLEMS OF JUNIOR COLLEGE STUDENTS TRANSFERRING TO A 4-YEAR COLLEGE

Clifford G. McCollum

Head, Department of Science

State College of Iowa

Cedar Falls, Iowa

Our college is deeply involved in the process of the student transferring from a two-year college to programs we have in science education. Approximately 34 percent of our present majors in the sciences, on both the liberal arts and teacher education programs, have transferred from other colleges. There are about 19 percent who have transferred from four-year colleges and universities, and 15 percent have had work in junior and community colleges. Most coming from junior colleges have had the full two years of work there and come to us as juniors. Almost all of the two-year colleges in the state are represented among those from which our present majors transfer. Therefore, our stake and our interest in the transfer process is great and we look at it as one of mutual concern.

In general, students feel they are not penalized with having two years at a junior college. In fact, many of them feel they have strengths that our own freshmen and sophomores do not develop. Many of these strengths have accrued from the opportunities available in informal teacher-student relationships not always possible with our beginning majors. They miss this kind of contact, or at least, feel they must be the ones to initiate it with us more than they had to at their junior college.

Of course, it is very difficult to generalize about background brought to us. There is at least as much variability among these two-year colleges as there is among four-year ones; possibly more. We are acquainted with variability within our own science departments. A lot of the variability rests with differences in teacher capabilities and effectiveness. More so, I am sure we would all agree, then with variabilities in facilities, although these are important also.

It is trite to state that science is built upon a quantitative base, but it might be helpful to remind ourselves that quantitative biology and quantitative earth science are as much the order of the times as is mathematical physics and chemistry. Therefore, juniors majoring in all sciences must have mathematical acumen and must be able to work with the communication skills and logic of mathematics. We look to two-year colleges to provide opportunties for science majors in mathematics, all sciences, humanities, communication skills, physical education, and the like.

A junior college cannot prepare all in terms of courses so labeled with prerequisites and catalog descriptions and credit hours to meet printed curricular patterns of all four-year colleges to

which their students go. And we can't expect all college and university curricula to be standardized in these terms either. We wouldn't want it. But all of us in college education need to sit together and consider common cores for freshman and sophomore years wherever the residence of the student may be. The concern should be for basic objectives to be sought rather than for duplicate registrars' statements.

It will be recognized that the student in junior college who is undecided as to his final major may be penalized more than one in such a quandary in a four-year college, but even these penalties could be reduced if we looked for fundamental background rather than for course titles. The problem, of course, is how to assess the degree of attainment of fundamental background.

All of these recognized situations point toward the need for better communication between junior colleges and four-year colleges. Conferences such as this help. But we also need to see and work with one another in our normal habitats, on our own campuses. As college nights are held in high schools with college representatives available to talk with students, so such meetings might be held in junior colleges with advisers and professors coming out from the universities to talk with students going to their schools. In some instances, the unofficial assignment of an SCI adviser to a junior college student planning to go there might provide a contact that would greatly reduce the trauma of transfer. The Iowa Academy of Science and its Iowa Science Teachers Section should be very effective organizations to promote cooperative study of basic objectives and to engender inquiry beyond specific courses, because within this realm reside the fundamental problems only hinted at by considering transfer credit, change of residence, meeting prerequisites for junior and senior work, and other "schoolmasterish" detail.

Degree-granting institutions should open their offices, laboratories, and classrooms to their colleagues in community and junior colleges for consultation, visitation, and common endeavors. This might be best on an informal basis rather than as elaborately planned meetings and group conferences. Cooperative research projects should be considered. I'm sure the point is made that the job to be done is not yours <u>or</u> mine; it's both yours <u>and</u> mine.

This, we know: Many of our graduates will spend their freshman and sophomore years in other colleges. We are not satisfied with what we are doing with our freshmen and sophomores, and we probably question what you are doing with yours. It is not for us to say we are right. Come--let us reason together.

ARTICULATION OF OBJECTIVES AND PURPOSES

Chalmer J. Roy

Dean, Sciences and Humanities, Iowa State University

Discussions of academic articulation between junior colleges and degree-granting institutions usually emphasize matters such as course titles, level at which specific courses are offered, credit hours, and grade-point averages. These are the external considerations of academic life. It seems to me that there should be more consideration of the internals of the intellectual enterprise. To the extent that this would include a discussion of courses, let the emphasis be on the content and intent of the courses. What is the level of attainment in understanding or skills that is expected of a transfer student in various areas of learning? Should the junior college seek to meet specific requirements for students planning to enter different degree programs or should it seek to provide a sound general background for advanced studies? Should the junior college seek to be all things to all people or should it seek to provide one program which will be an intellectually sound head start for those who are either upward bound or outward bound? Can the junior colleges and degree-granting institutions agree on a statement of the objectives and purposes of higher education which will be meaningful to students in the seventies and not just self serving.

Post-high-school education in Iowa may be at a fork in the road. In one direction lie increasing numbers of degree-granting and junior colleges--public and private -- and each going its separate and isolated way to establish an intellectual or geographic empire. Such empires seek to create weak degree-granting institutions from strong junior colleges and weak graduate programs at strong baccalaureate institutions. In the other direction lies integrity in higher education in Iowa. Institutions along the way go their balanced, but not separate and isolated, ways. There is communication, understanding, and many varied productive working relationships among the colleges and universities. There is common understanding of the purposes and functions of higher education, its problems, its strengths, and its weaknesses. Higher education in the direction of integrity has a coherence which helps it resist distorting pressures for casual, opportunistic development. It enjoys the confidence and support of the people of Iowa who recognize and appreciate competent, unselfish public service.

Although we are not here to chart the course of higher education in Iowa, we should avoid doing anything which will hinder its orderly and systematic growth. To conclude that effective articulation between junior colleges and degree-granting institutions is, or should be, easy might well be a disservice to education and to Iowa.

To participate in this panel, it seems to me, one must clearly state the educational perspective from which he speaks. I have been invited to speak from the perspective of a liberal arts dean.

However, I am not all liberal arts deans, and I could not possibly speak from a perspective typical of such deans or the academic units which they represent. I must speak from the perspective of an institution which was recently described by Dr. Parks, its president, as "... a broad-based, diversified institution, oriented around science and technology; an institution of high excellence, which has the will and the capacity to pioneer in developing the kind of total education this age requires; an institution deeply committed to serving the larger community."

In his inaugural address last spring Dr. Parks spoke of liberal education as follows: "... in the modern world, the liberal education--the humanistic education, if you will--is one in which an understanding of the language and the meaning of science must be an integral part. Science, I believe, must be inseparably at the core of the modern liberal education. This conclusion can be derived from the liberal education's own view of itself, its self-established purposes and objectives, its own criteria for judging the liberally educated individual.

"Both science and the arts and humanities spring, I believe, from the same capacities and qualities of the human mind and spirit. High scholarship in each area holds to the same values: accuracy, truth, precision, discipline, tolerance, freedom, creativity, imagination. It is significant, I think, that science had its origin in the Greek mind, the same free, curious, and critical Greek spirit which also produced the first history and first western philosophy." May it be added here that these were the same Greeks who recognized and developed the seven liberal arts which have been traditional--almost sacred--in western society.

Our experience with junior college transfers at Iowa State has been good. It is clear that we get some of the best -- two years ago our highest ranking senior was a junior college transfer. Not all who transfer to us are your best, but the average is good.

In the College of Sciences and Humanities we preach and we practice the liberal arts. We do have modest requirements in mathematics, the social, biological and physical sciences, and in the humanities. Most, or all of these requirements can be met in junior college. The broader the base the greater will be the freedom of the student to select a major from among the thirty or more we offer. Academic minors are required, but they may be selected across the university as appropriate. It is desirable but not necessary for students to declare a major when they enter--many of our juniors have not declared majors.

Speaking from this perspective there seem to be several considerations which will be essential in any effective articulation of the junior colleges and degree-granting institutions.

The junior colleges, each serving a smaller and generally more homogeneous community, can effectively maintain articulation with the secondary schools. However, at the same time these colleges must establish an intellectual environment adapted to young men and women rather than to boys and girls - a program designed to develop the individuality of higher education. A thinking man at work must work alone.

There must be suitable and adequate facilities--classrooms; a library with adequate reference materials but also essential scholarly journals in the basic areas of learning; laboratories; and facilities for recreational, cultural, and social activities. It must be possible for college freshmen and sophomores to explore original sources in at least a few areas of learning.

The junior college faculty must be qualified, and must be given the time and facilities, to engage in scholarly contemplation. In general these people must be fascinated with learning rather than fascinated with knowing. They must be qualified to engage in a partnership in learning, original learning, with students. Someone has said "He who learns from one occupied in learning drinks of a running stream. He who learns from one who has learned all he is to teach drinks the green mantle of the stagnant pool."

The junior colleges must become partners with the senior colleges in an intellectual enterprise worthy of the times. The common objectives and purposes of higher education must be the primary objectives and purposes of all kinds of colleges. Ideally, these objectives and purposes can be described as realistically meeting the needs that students will have 20 or 40 years after graduation. The accelerating explosion of knowledge and the increasing tendency for careers to be shorter lived than people, suggest the magnitude of the problem. Stuffing students with knowledge or preparing them for specific vocational objectives is clearly education for obsolescence. For the sake of the student, high priority should be given to programs and processes which help the student develop the ability and desire to learn - learn anything he will ever need to know without taking courses. In short, we must prepare the student for a lifetime of self-directed learning. Rollo May a clinical psychologist says "The truncation, the withdrawal, the apathy, the lack of zest, the giving up of genuine hope at thirty five is a symptom of the failure to continue to grow educationally...It's a symptom of having expected that college would do the whole job." Does your college do anything to disabuse the students of the idea that the college will do the whole job.

To the junior college falls the primary responsibility for effective literacy. This is something more than legal literacy. It is also something more than rapid reading although this is a part of it. Someone has said that there are three kinds of reading: reading the lines; reading between the lines; and reading beyond the lines--the latter is a part of effective literacy. It includes, first of all effective literacy, reading, writing, and speaking in English, but this is not all of it. There should also be effective literacy in mathematics--the language of science and technology, and effective literacy in a scholarly language other than English. There is no escaping the fact that effective literacy is the most important tool of a thinking man at work. It is minimum equipment for a lifetime of self-directed learning. If attaining effective literacy is postponed beyond the first two years of college, the damage is irreparable. Any student, effectively literate, can transfer to any degree-granting institution and perform with distinction.

Effective literacy is of small consequence unless it can be employed in a continuing process of analysis, interpretation, and synthesis in order to go beyond knowledge. Logic, the processes of inductive and deductive reasoning must also have high priority in the school years represented by the junior colleges. The importance of intuitive reasoning to those who would master the art of learning the unknown must be conveyed to junior college students by example as well as by word. Thus grammar, rhetoric, and logic the trivium of the seven traditional liberal arts, plus mathematics (embracing two arts of the quadrivium) become a peculiarly fitting responsibility of the junior college if effective articulation is to be achieved.

Of the higher liberal arts of the quadrivium only music and astronomy have not been prescribed. Music should be thought of as embracing all of the fine arts. Astronomy stands for our modern sciences. Recent developments in the teaching of science in the elementary and secondary schools pose questions respecting its presentation at the college level. The practice in secondary schools is to offer courses in the sciences (biology, chemistry, physics). The newer course materials place a refreshing emphasis on concepts and principals. The rapidly declining percentage of high school graduates who have had more than one course (biology), two courses (biology and chemistry), and three courses (biology, chemistry,and physics) is distressing, however. The average background of high school graduates in science is inadequate for intelligent, adult laymen in 1980 or the year 2000. Circumstances have never been more favorable for the development of programs in science to replace the traditional courses in the sciences. It has been suggested that a unified program in science should extend from K through 14. This then could be of interest to the junior colleges as it might provide increased effectiveness and a lower demand for facilities and staff. It would raise new problems of articulation with senior colleges. The new problems could hardly be more trying than the perennial ones.

Science instruction in junior colleges will always face the real difficulty of expensive facilities. The essential equipment is ephemeral so that keeping laboratories up to current requirements is a recurring item of expense. There is little reason to believe that the level of sophistication in science courses for non-science majors should be notably lower or less expensive than those for beginning science majors. For the present it would seen advisable for junior colleges to avoid the problems of meeting transfer requirements in science beyond the first-year courses.

The social and behavorial sciences are areas in which elementary courses can be offered without extensive and expensive specialized facilities and equipment. Minimum requirements for library resources may be greater in these areas. Care should be taken to avoid offering college courses which are merely high school courses "in more detail." These areas of learning do raise more problems related to the competent handling of dissensual subject matter. To confine the course content to consensual information would be a disservice to the students.

The real problem in establishing effective articulation is the serious shortage of competent manpower. For at least another half-dozen years higher education, as well as our whole economy, must be staffed with depression babies. They were too few and too small a percentage of them pursued higher education even to the baccalaureate.

Personnel competent to serve effectively on the teaching staff of junior colleges are now eagerly sought by senior colleges. In general the senior colleges can pay higher salaries and have more "fringe benefits" such as opportunities to do graduate work. Some junior colleges have recruited the more able faculty from the high schools. It is difficult to see how this contributes to the improvement of education.

Effective articulation of the junior and senior colleges in Iowa will not be effected by agreement on the external factors of higher education. It must come first from a mutual feeling on the part of all of us that we belong to a common intellectual community. It must come out of common agreement on the objectives and purposes of higher education as a service to students and to society. It must come out of our understanding as institutions, of the need to bring our separate, specialized competencies to bear cooperatively and productively on the solution of our problems.

PROBLEMS OF JUNIOR COLLEGE STUDENTS TRANSFERRING TO A 4-YEAR COLLEGE

Richard V. Bovbjerg
University of Iowa

On this panel I am billed as representing basic biology at a large state university. While this describes part of my position at the University of Iowa, I cannot speak for biology or for the university. My comments are my own, and I choose to tackle what I feel are the basic points.

It seems clear that more and more young people will have their first two years of college education in junior colleges. In this state the freshman and sophomore population at the large universities will increase less than will the upperclass, graduate, and professional school populations. Therefore, the title of this panel has great meaning. The problems of transferring are real.

One always says in starting such a discussion of problems that there are two parties to a problem. In this case the two parties are the junior colleges and the four-year colleges. I will back away from this practice and claim that the greater responsibility here lies with the junior colleges. Also, in the panel title are the words "transferring to" which make a one way street of responsibility. It is very true that the junior colleges have internal responsibility to their own terminal students but that is not part of our discussion.

The number one responsibility of the junior college is to insure that its students are as capable of handling upperclass courses as are the students of the four-year colleges. There is no reason why this cannot be done. I imagine that the records would show however, that it has not been done. The junior college faculty should know what is expected of upperclassmen at the colleges and universities and make a real effort to prepare their students to meet these expectations.

To do this, the science faculty must know their field and be good pedagogs. In an important way the junior college instructor has an advantage over the university instructor in that he has smaller classes, more personal contacts, a more informal laboratory, and after hours contact. My personal notion would be to stay away from two things: 1. teaching potential four-year students in advanced courses, leave these for the four-year institutions and do a superlative job with the basic course; 2. pushing science-fair type extracurricular science. The first-year student needs the time in the basic disciplines.

May I apologize for this big brother attitude; I am personally a modest man. But it seems very clear that the major responsibility in the solution of this problem lies with the junior college.

There must be something that the four-year college can do, however. We must communicate with the junior colleges. This is easy to say and difficult to do. How can a junior college staff train students for the four-year college without knowing what is going on at the latter?

The four-year college should be ready to assist in any way; the major assistance could be with information. Information is needed about curricula, courses, men, and special fields.

All four-year colleges should be ready to send all junior colleges their introductory course outlines, syllabi, and examinations. Heaven forbid that the junior colleges model their courses slavishly on these outlines! One can achieve the same or better results in numberless ways.

The junior colleges should know what the advanced courses are in the four-year schools and what the prerequisites are. Only by knowing this can they intelligently prepare their students.

Then we at the large schools should be ready to furnish information for student counselors at the junior colleges. This must be a very important aspect of transferring students. Is it well developed in the junior colleges? I do not know. On what grounds do the students select the larger school for the completion of their degree program? I suggest that a knowledge of the men and programs in science would be of absolute importance. Some are obvious; a pre-med might select Iowa City, an agronomist, Ames. But what of a student who really would profit from a smaller four-year school? Which of the smaller four-year schools have good men in chemistry? Or a potential physicist might do better at Ames or better at Iowa City, depending on the particular type of physics he hoped to get into.

I would propose that the Academy of Science establish a clearinghouse for this information flow. Much of this could be done with catalogs and clerical help. Much of it would need to be done by questionnaire and perhaps actual interview with knowledgeable men. Such a clearinghouse would need to be current, with continual revision. Could not such a project be funded by agencies or perhaps ultimately be taken over by a state educational agency?

PROBLEMS OF JUNIOR COLLEGE STUDENTS TRANSFERRING TO A 4-YEAR COLLEGE

James Divelbliss

Westmar College

At Westmar, we have not experienced any serious problems of articulation, according to our present registrar and his immediate predecessor. Their service covers a time span of approximately ten years. This lack of problems is in part due to the relatively small number of junior college students who have chosen to transfer to Westmar. With this limited personal experience at the level of specific problems of curriculum articulation, I felt it might be better to address myself to more general problems which the junior college transfer might face.

It would seem that one problem area is related to students' indecision as to educational goals when they enter the junior college. They may, for instance, start a two-year terminal course or some type of a specific pre-professional course and then sometime during their first or second year decide they want to change to a liberal arts course and transfer to a liberal arts college. Because of the nature of the program they have been taking, they may often lose credits when they do transfer. This loss of credits may mean a summer term or an extra semester, a situation which might cause some real problems for the individual involved. This is a problem for which the junior colleges cannot be blamed, but if they anticipate the problem, they may be able to encourage an earlier decision toward such a change, if this change seems warranted, or inform the student of these problems by pointing out such options during the first registration.

The first-year college student must be made fully aware of his responsibility in helping to plan his own curriculum. For many high school students curriculum planning has largely been a formal matter done for them by their high school counselor or another faculty person. It would seem that this type of pattern must be guarded against at the college level. To be sure, the counselor will have much to do with the planning of an individual curriculum, particularly in the first semester or first year. However, I feel it is the responsibility of the counselor, whenever possible, to throw responsibility on the shoulders of the student. This will involve not only the selection of specific courses, but also a constant reexamination of ultimate goals on the part of the student. The counselor may have to serve as a braking mechanism at times, but I feel that he and the student should both attempt to find that particular curriculum which will best serve the student's goals and needs. At least, then, if the student changes his mind, the counselor will be able to say he acted in good faith for the good of the student.

A different type of problem may arise when the student has his goals firmly established and does not change them. A good percentage of first-year college students seem to be in this category. When students know where they will transfer, then the junior college counseling program must take this into consideration. The counselor should consult the

catalog of the four-year college so that the proper curriculum can be started. It would seem that the two areas of major concern should be: (a) the basic liberal arts courses necessary for graduation from the four-year college, especially those which are taken during the freshman and sophomore year, and (b) the specific science requirements which are required for the major, minor, or other graduation requirements. It would seem that at least these considerations should be taken if adequate counseling is to be given to the student and he is not to experience problems when he transfers.

At this point, I think it needs to be pointed out that the four-year colleges perhaps will need to be a little more flexible in their handling of these transfer students. Each four-year college is, of course, autonomous in terms of its requirements, and this creates certain problems for the junior colleges, particularly if the student is not certain to which institution he will transfer. However, if the four-year colleges can be a little more flexible, it may ease the situation. Perhaps an example will help to illustrate what I am trying to say. Last year we had come to us a junior college transfer who had taken comparative anatomy, but had not taken embryology. Both of these courses are commonly required for biology majors. In counseling with the student it was discovered that the course also included a considerable amount of embryology, even though there was no indication of this on the transcript. Upon a closer examination of her lab notebook and other class work, we felt that she should be given credit for this work, and therefore, it was decided that she had also met our embryology requirements. I'm not pleading here for a blanket pattern in this respect, but I do feel that some flexibility is necessary.

I feel that this problem of articulation, therefore, is a two-way street. The junior colleges on the one hand, will need to be aware of the four-year college requirements, but the four-year colleges will also need to show some flexibility. Perhaps, therefore, the present problem of articulation is not solely due to inadequate preparation on the part of the junior college, but also due to the inflexibility of the four-year college on evaluating individual situations. I feel that work must be done at both levels to ease the situation.

We might now turn to some more specific suggestions. In conversation with a colleague in a state university in a neighboring state, the following two suggestions were given. It is important that the junior colleges provide a laboratory experience in the introductory courses, since the lab is almost invariably offered in introductory courses in the four-year colleges. This experience will better prepare the student for his advanced courses when he transfers, and the four-year college will be better able to accept the course at full value. This statement may not apply to any junior college in Iowa, for they may all offer the lab experience, but apparently in the area servicing the university in question, the lack of lab courses does present a problem. The question was also raised as to the advisability of offering advanced level courses in the junior college. It would probably be better if the junior colleges concentrated on the courses normally found in the first two years of the science curriculum in most of the four-year colleges in the area.

It was also suggested that if the junior college concentrated in general on preparing for the requirements of the state universities, the transfer students would also be prepared for most four-year colleges. I would disagree with this view to this extent. Most of the smaller liberal arts colleges have biology departments and, therefore, will have certain different major requirements than has the university with separate zoology and botany departments. A concentration on offering just the beginning requirements of the state universities might create definite problems for one transferring to another type college.

The awareness of the problems of articulation which led to this conference indicates a healthy situation in the area of science education. This awareness means that we are not burying our heads in the sand, but that we are trying to come to grips with a real problem. I hope that from our discussions will come helpful suggestions to both the junior colleges and the four-year colleges as we together try to meet this problem.

SECTION MEETINGS

I. Science Defined: The Methods, Teaching the Scientific Enterprise to Freshmen and Sophomores

Questions asked during sessions:

1. What is the meaning of the term "science?"
2. In your own teaching what do you teach regarding inquiry by students?
3. In junior college is there more of a compulsion on a teacher to get students through a course than in a large four-year college?
4. How do you get a student to think instead of memorize?
5. What do we as teachers know about the learning process?
6. Will every student learn the same things the same way?
7. Do you use team teaching in your school?
8. If so, how do you tie team teaching together?
9. Should you use student appraisal of your team teaching?
10. What is the objection to team teaching?
11. What is the purpose of a test?
12. Should one use scientific journals in teaching, and if so which ones?
13. Is duplication of material good or bad? How much time should be spent on duplication of previous material, and is it worth it?
14. Should one consider a student's readiness to learn certain concepts?
15. How does one test the student on his ability to engage in scientific inquiry?
16. Learning involves the use of all senses. What is a student doing to learn about a given concept (such as photosynthesis)?
17. What are some ways to set up problem analysis in the laboratory to stimulate inquiry by students?

Section IA

Delma Harding, Chairman, Iowa State University
Thomas Rider, Recorder, Grandview College

A. What is the meaning of Science?

1. Consensus:

a. Is there a good definition?
b. Systemized knowledge
c. A human process that yields results
d. Experimentation and discovery
e. Answers how not why
f. Hypothesis approach to problem solving
g. Knowledge and comprehension of the truth on any subject
h. That which uses the scientific method

2. Disagreement:

   a. Not moralized as are theology and philosophy
   b. Shouldn't science be concerned with why?

B. Individualized Teaching (primarily in the laboratory)

1. Observations and Suggestions:

   a. Role of a teacher is to lead the student to the best interpretation of experimental data, but to let him decide for himself.
   b. Student should understand how he arrived at his conclusions even if they are in error.
   c. The teacher is <u>not</u> an encyclopedia for use by the student.
   d. Teacher should be active with his students <u>outside</u> the classroom.
   e. A teacher must continually retrain himself by further study in his field.
   f. The use of scientific journals is desirable where practical. (irrelevant?)
   g. Teacher should recognize that not all students learn the same way.

2. Team-Teaching Generalizations:

   a. Difficult in a one-man department

   b. Strengths:

      (1) Each person lectures in his own field.
      (2) Student gets a different slant on the same topic.
      (3) Competition among instructors for best presentation improves the overall teaching.

   c. Weaknesses:

      (1) The student is faced with several instructors with whom to identify (team teaching is <u>not</u> individualized).
      (2) Aggregated instruction is of higher quality.

   d. Consensus:

      (1) "Organization plus" is the heart of successful team teaching.
      (2) Meetings of team members are essential.
      (3) If one <u>really</u> wants team teaching, other problems can be worked out.

C. Teaching the scientific enterprise to freshmen and sophomores

1. Discussion, observations, and questions

a. Too much teaching emphasizes <u>recall</u> and <u>not</u> thinking.

(1) Recall is easy to grade; thinking is not.
(2) Grading is unfortunate, although necessary.

b. A teacher using the "thinking" approach must himself work harder, thus benefitting his students.

c. "Thinking" teaching encourages debate (there was much debate in this discussion section).

d. Do we teachers really understand this thinking-learning process?

e. How do you get a student to think and not memorize?

f. The best way is to learn to teach.

g. Is duplication of previous course material useful?

(1) Leads to a different slant
(2) Technique of presentation may vary

h. Does the junior college instructor want to get a student through a course more than does an instructor in a large four-year college?

i. Students demand memorization and are unhappy if you test over something you didn't cover in lecture.

j. Learning involves <u>all</u> senses. What is a studen<u>doing</u> in your classes to learn a given concept?

k. What are the ways to set up problem analysis in laboratories to facilitate this "doing" process?

(1) Discussion of black box hypothesis (lengthy)
(2) How does one test a student under these conditions?

<u>Section IB</u>

Louis Bosveld, <u>Chairman</u>, Mason City Community College
E. Russell TePaske, <u>Recorder</u>, State College of Iowa

A. Definition of science

1. Science is the process of the observation of nature's happenings.

2. Science is an attitude toward the happenings of nature.
3. Science is the formulation of hypotheses concerning the mechanisms whereby happenings in nature occur and descriptive and/or quantitative measurements of these happenings.

B. The role of the laboratory in science

1. The laboratory is a place where students demonstrate to themselves the applications of science theory. It is the heart of science courses and may be used both for verification or confirmation of science theory and for extending theory through open-ended experimentation.
2. The following were suggested as valuable laboratory learnings:

   a. Significant figures
   b. Error analysis to discover sources of error
   c. Interpretation of data
   d. Possibility that many experimental situations terminate in failure
   e. Repetition data taking from classical studies to determine how classical hypotheses evolved

3. There should be fewer laboratory periods of long duration covering 6-8 good experiments. (Most laboratories as we run them in science are inefficient, ineffective, and a waste of time).
4. Instrumentation should be incorporated into experiments as a vehicle for research, and be used not as an isolated exercise by itself.

C. Mathematical proficiencies of students

Math through probability and statistics is probably a more realistic requirement for biology majors than is calculus.

D. The use of the library in science teaching

No participant indicated capability in motivating library research by other than force and/or punitive methods. Some such methods included:

1. Testing over readings
2. Replacing one or more tests with a research paper
3. Annotated bibliographies
4. Sending students to find answers to real and/or contrived problems

II. Science Integrated: The Courses, Common Demoninators in the Sciences

Suggested points for discussion:

1. What should science courses contribute to the education of students who will not be scientists? Should a science course (or courses) in any discipline be able to make this contribution, or does it require courses in more than one discipline?

2. What important principles or concepts are common to all science disciplines and would likely be emphasized in any science course?

3. Are courses which deal with a variety of disciplines better able to impart the concepts and principles of science which are important in the education of every student than are those which are restricted to a single subject area? We might call the courses which deal with several disciplines "integrated courses."

4. Assuming that "integrated science courses" are going to be taught, would they be more effective at the junior-senior level than at the freshman-sophomore level?

5. What are the possibilities for an integrating science seminar at the senior level with participating staff members from all the science disciplines? This would probably assume a science course (or courses) at a lower level.

6. What would science courses contribute to the education of all students who will become scientists? Should a core of subject matter, principles, and ways of thinking be required of those who are planning a future in science?

7. Do our science majors have a depth and breadth of knowledge which provides for an integrated understanding of science?

8. Is it the obligation of the faculty, curriculum, or student to integrate science? Is it the subject material or the method of teaching which is most critical in the process?

9. Should there be a set of core courses required of all students prior to the junior year as greater mobility of students occurs and greater numbers attend junior colleges?

10. Can the junior colleges revise their offerings without similar revision of beginning courses at four-year schools?

11. What specific actions could be taken by colleges and by individual instructors to improve the integration of the sciences?

Section IIA

Walter DeKock, Chairman, State College of Iowa
Marvin P. Jessen, Recorder, Grandview College

The number of individuals interested in this section dwindled to very few by Saturday morning, and section disbanded. Therefore, the ideas summarized below represent only the first session and are those that seem to apply most directly to the assigned topic:

A. Basic science courses should serve as a broad background for both major and nonmajors.

Both majors and nonmajors would benefit from a broad base of literacy in the sciences. Ideally, these two groups of students should not be placed in separate sections (i.e., not tracks).

Quantitative emphasis was felt to be of special importance for the major. Considerable discussion centered on the problem of being able to use a quantitative approach for majors and a less quantitative ("qualitative") approach for nonmajors simultaneously (i.e., in a mixed group). There was no consensus on this problem.

B. The continuity or principles and concepts common to all of the science disciplines might include the following:

1. Atoms and molecules.
2. Energy
3. Basic methodology
4. Common point of emphasis: to encourage the student to independent thinking, theorizing, and synthesis.

Section IIB

Donald M. Huffman, Chairman, Central College
William Azbell, Recorder, Wartburg College

Sciences appear to be integrating. We have biophysics, biochemistry, astrophysics, physical chemistry, geophysics, and the like.

The group came to no definite conclusion in regard to whether courses that cut across areas are better than the traditional alignments.

An integrated college science course may go to a high school level course. But this need not be, and the group thought that it could be kept on a high level.

Some things may be lost by integration. For example, some priciples are presented from different viewpoints by the chemists and physicists.

Two of the members did not think that team teaching was successful as far as integration of subject content was concerned.

The responsibility for integration is with the teacher. Faculty is the greatest problem . It is difficult for a teacher to be well trained in many areas.

Professional people: Content of courses for majors was left open as it was mentioned that the admission committees to medical schools were revising their requirements. However, it was agreed that engineers should not take integrated science courses.

There is an integrated freshman science course (one year) at Michigan State University dealing in both lecture and laboratory work.

Section IIIA

Emil Miller, Chairman, Luther College
Howard Bath , Recorder, Fort Dodge Community College

Section IIIB

William Schmidt, Chairman, Ellsworth College
Harvey Lundy, Recorder, Estherville Community College

Summary of topics discussed:

A. Is there a need for two kinds of courses at the elementary level (for science and nonscience students)?

1. The majority of the discussants seemed to feel that there was a need for (at least) two kinds of elementary courses which should be offered for the beginning student.

   Problems involved:

   a. Number of instructors on staff
   b. Obtaining instructors who are interested in, who are prepared for, and are willing to teach a course for nonscience majors

2. If a course for nonmajors is to be offered, should it be a general science course or should each department offer its own course?

   a. A general science course, with members of various departments participating (team teaching)
   b. Each department might offer its own course for nonscience majors. Easier to do but perhaps less desirable. (Could, however, be correlated with high school background in science to fill in the gap)

B. How can we identify science and nonscience majors at freshman level?

1. By questionnaire
2. By test scores
3. By counseling
4. In case of real doubt, let the student take math or any of the science courses in an attempt to find where the student belongs in science area. If he takes a course for nonscience students and develops an interest, no harm done. Math is useful in anything.

C. What should be the nature of a course for nonscience students?

1. Suggestions were made that it should not be a "survey" course or a "watered-down" type of course.

2. It should be meaningful to the student, less technical and mathematical than are courses for science majors?

D. Is there a common core among the various science courses for science majors?

1. Suggestions were made that it might be feasible to offer a beginning course which would include topics common to several or all science courses in an attempt to reduce "overlap"which often occurs in the various sciences taken by the science major.

2. More advanced courses in the separate sciences would take off from this core.

President Maucker and Dr. Andrews, at the Saturday morning section meeting, provided points in their speeches to supplement the discussion:

1. Iowa is committed to a diverse program.(Dr. Maucker)

2. One biology course would suffice for all students.(Dr. Andrews)

Summary of questions discussed:

A. Do we need one, two or three sets of science courses to meet the diverse needs of two year students?

Response:

1. Still need for two-track program
2. Major goal for science major was suggested to be "facts." Historical and process-centered was suggested to be more interesting to nonscience majors
3. Discussion of a historical and demonstration type of course for nonmajors.
4. One school has two tracks in physics--completely different courses and loss of credit for terminal students if they try to go on!

B. Do we identify terminal or majors in science during or before the initial science course?

Response:

1. Mention of concern for low number of high school and college students that never are exposed to physics.

2. Also concern expressed about the image of the scientist and the understanding of science.

3. A program of "general science" sequence including physical science, earth science, and biological science (the sequence required). Also, concern about the math along with this.

C. What is taught to nonscience major that is not good for the science major?
What is in advanced courses that is not good for the slow student?

D. Who is going to teach the general courses for nonmajors?

Suggestion: Perhaps math is a good start for anyone who isn't decided.

Response: How can you get this into the course?

E. What is the possibility of a combined physics-chemistry course or combined chemistry-biology to avoid overlapping of subject matter?

Other statements and conclusions:

A. A definite statement was made to point out the fact that this conference did not emphasize mathematics--the fact that math is basic and functional for all science teaching.

B. It was proposed that basic, functional math can be taught to slow students if it is done properly.

C. How many freshmen-sophomores even know whether they are going to be science majors or not? Thus, a two-track program is dangerous!

D. Is the old traditional course for majors satisfactory?

E. Defense of the two-track program was made on the basis of the idea that "good students" would lose interest in a slower course when it takes a long time to get points across.

F. Dr. Andrews pointed out that most two-track programs really "boil down" to two sections of the same thing. He believes that one course aimed at the literate "man on the street" would be sufficient for basic biology, basic physical science required--but giving good students a chance to test out of this first course.

IV. Applied Science or Academic Science: Who should teach it?

Section IVA

Sherwood Tuttle, Chairman, University of Iowa
William Pecha, Recorder, Muscatine Community College

Section IVB

John Page, Chairman, Mason City Community College
Donald Biggs, Recorder, Iowa State University

Questions related to this topic:

What kind of mathematics does the computer technician need? And who should teach it--the mathematics department or someone who works in computer programming? Should there be a physics course for electronics technicians taught by electronics instructors or by the faculty of the physics department? After all - is there a basic difference between applied and academic science? The group should try to decide what characteristics applied and academic science have and what kind of instructor can best teach each one. With the new emphasis upon the Vocational-Technical Schools, this area is becoming a basic problem. The State Department of Public Instruction should be able to provide information regarding Vocational-Technical Schools.

Developing Threads of Thought

1. How can you identify academic and applied science?

2. Are "applied science" students different from "academic science" students?

3. Do instructors in the two kinds of science need different types of training?

4. Should an applied science curriculum include some academic science courses?

In defining applied science, we ran into some difficulty. It was generally agreed that the vocational schools were teaching a technique, giving the student something he can get his hands on in a short period of time. We were undecided whether this was actually science or not. There would, however, be some applied science which probably requires some basic understanding of science.

The vocational student wants to learn a skill without the burden of a general academic curricula. His ability may be sufficient to study academic subjects or in some cases he may be a transfer from an academic school because of deficiencies in grades. No definite criteria can separate the two groups into separate classes.

The ideal teacher would be one with both academic and on-the-job training. Some people questioned whether an instructor could organize and relate his material to the students without educational training. Probably his knowledge and interest of his skill would be a sufficient background. A major problem is that some vocational schools are completely separated from the academic institutions. It would be a definite advantage if the campuses were closer together. But definitely a vocational instructor should teach the subjects. If some academic courses were offered, a criteria for certification to teach this should be mandatory. Any academic courses that could be placed in a vocational curricula would be good.

One major problem is that the program is too short ranged. Since transfer is not possible to a four-year school, the student is limited to his learned skill. If the skills change, he would have to return to a new vocational school or the schools could eventually expand to deal with more modern and complicated techniques.

FOURTH GENERAL SESSION

ACTIVITIES OF THE COMMISSION ON UNDERGRADUATE EDUCATION IN THE BIOLOGICAL SCIENCES

Ted F. Andrews, Director of Science
Educational Research Council of Greater Cleveland

The Education Committee of the American Institute of Biological Sciences conceived the idea of science curriculum development projects during its deliberations in 1957-58, and, as a result the Biological Sciences Curriculum Study was initiated in 1959 with H. Bentley Glass as Chairman and Arnold B. Grobman as Director. During the next several years, the BSCS was very active, producing three versions of high school biology and numerous other publications. The impact of the BSCS on the high school biology curriculum need not be re-stated here. However, it is worth recalling that hundreds of biologists, high school teachers, and science educators were involved in the production and try-out of the BSCS materials. It seems abundantly clear to me that feedback from the biological community to the Education Committee of AIBS had considerable influence on the initiation of the college biology curriculum improvement program.

In 1963, the Commission on the Undergraduate Education in the Biological Sciences was formed, with Thomas S. Hall as chairman. For the first year, Dr. Hall served both as chairman and director, and in 1964 Victor A. Greulach was appointed the first executive director. Martin W. Schein assumed the duties of executive director in September 1965, and Earl D. Hanson was elected chairman of the 24-member commission and of the 7-member executive committee.

Early in the history of CUEBS, the Commissioners decided that it was necessary to convene a broad spectrum of representatives from the biological community to identify the areas that biologists felt needed improvement in undergraduate education and to gain insight into the tactics and strategies that CUEBS might best use to influence change. To this end, a series of regional conferences and many state meetings of biologists were held. In addition, several advisory groups were invited to make recommendations.

As I reflect on the deliberations in the conferences and meetings, most of the problems that were identified seem to group naturally into six categories:

1. The Research-Teaching Gap

   There exists too great a disparity between the state of the knowledge of biology, as reflected through the research effort, and what is taught and learned in the classroom and laboratory.

2. The Structure of the Knowledge of Biology

   It is evident that the body of biological knowledge should be re-examined and structured into more meaningful schemes; e. g., biological levels of organization

probably make more sense than does phylogenetic.

3. Core Biology

There is a core of biological knowledge that is basic in the learning experience of all biology majors (premedical, preagricultural, biology teachers, et al.), and it probably should be experienced over a two to three year period.

If the first year of core biology is properly planned, structured, and taught, it should be a valid experience both for the majors and the nonmajors.

Core biology should provide learning experience in molecular, cellular, organismic, environmental, genetical, evolutionary, and behavioral aspects of biological knowledge.

4. Relation to Cognate Sciences

There are meaningful interfaces between biology-physics, biology-chemistry, etc., that the biology major should understand.

At least one year of appropriate college physics and chemistry, including organic and preferably bio-chemistry, is desirable, if not essential.

5. Instructional Personnel

Major deficiencies exist in college biology programs for prospective high school teachers, and most university programs do not adequately prepare instructional personnel for two-year and four-year colleges.

6. Instructional Materials and Facilities

Laboratory instructional materials are largely descriptive, hence do not illustrate the processes of science, are not student-centered, and are not investigative.

Few, if any, college biology textbooks reflect the current state of biological knowledge, and the information is not structured appropriately.

Introductory college biology materials for nonmajors are essentially nonexistent; most are aimed toward the prospective biologist.

Biological facilities are often out-of-date when constructed, and so much inflexibility is built into the facilities that adaptation is usually not feasible.

Too little attention has been given to the ways in which contemporary biology should be experienced by the student.

In order to facilitate improvement in undergraduate education in the biological sciences, the Commission established 11 action panels, as well as several subpanels, action committees, and advisory groups, each of which has generated a wide variety of programs. A newsletter, CUEBS NEWS, is published bimonthly and mailed to more than 10,000 biologists; it is a vehicle to inform the biology community of the Commission's activities and to publicize interesting curriculum developments.

The remainder of my presentation is concerned with the current CUEBS activities that are listed in the Newsletter CUEBS NEWS; Annual Report, Volume II, No. 6, August 1966.

HIGHER EDUCATION IN 1980

Richard M. Harbeck, Director of Education
The Franklin Institute
Philadelphia, Pennsylvania

Any reasonable prediction of future changes in higher education must necessarily be based on observations and interpretations of what is taking place today in society in general and in education in particular. The following observations provide some of the rationale for points to be made later.

Our rapidly growing society demands more and more from the educational institutions it supports.

Educational institutions face more and more competition for the best people needed to teach and administer programs.

The present organization for education precludes any high degree of efficiency in educating people because:

1. It ignores the idea that people learn at different rates and by different means.

2. It uses teachers to convey information as against more efficient methods.

3. It assumes discipline structures (e.g., course contents) based on calendars rather than on the needs and abilities of the learner.

4. It provides little opportunity for planning and building the kinds of facilities designed for learning rather than for purposes of classroom teaching and administrative convenience.

By 1980 there should be clear evidences that change is taking place in higher education. Among these evidences, several will be of special interest to science educators. These can be expected to be:

1. Further organization of small residential and self-contained schools on large university campuses.

2. Less dependence upon rigid, management-oriented course structures and student groups.

3. Much greater use of educational technology to provide for true individualization of instruction.

4. More evident trend toward emphasis upon the learner and away from emphasis upon factural content.

5. Curriculum efforts will be in direction of producing a wide variety of learning materials from which can be selected sequences appropriate to the individual learner.

6. Greater acceptance of the role of the instructor as a manager of the learning situation and as a supervisor of instruction.

7. A growing trend toward considering the basic sciences as tool disciplines in the same manner as mathematics is now considered.

CONFERENCE PARTICIPANTS

Ted Allen
Muscatine Community College
Muscatine, Iowa 52761

Harold D. Anderson
Eagle Grove Junior College
Eagle Grove, Iowa 50503

Dr. Ted Andrews
Associate Director, CUEBS
1717 Mass. Ave., N. W.
Washington, D. C. 20036

Clinton Asche
Ellsworth College
Iowa Falls, Iowa 60126

William Azbell
Wartburg College
Waverly, Iowa 52002

W. R. Babcock
Webster City Junior College
Webster City, Iowa 50595

Paul H. Bacher
Burlington Community College
Burlington, Iowa 52601

Norman C. Baenziger
University of Iowa
Iowa City, Iowa 52240

Lyle D. Baker
Mason City Community College
Mason City, Iowa 50401

David Barry, Associate Dir.
CUEBS, 1717 Mass. Ave., N/W
Washington, D. C. 20036

Howard Bath
Fort Dodge Community College
Fort Dodge, Iowa 50501

Dean Beckwith
Keokuk Community College
Keokuk, Iowa 56203

Rudolph J. Beneke
Burlington Community College
Burlington, Iowa 52601

William G. Bennett
Eagle Grove Junior College
Eagle Grove 50503

Dr. Donald Biggs
Iowa State University
Ames, Iowa 52240

Robert O. Birkhimer
Community College Division
Dept. of Public Instruction
Des Moines, Iowa

Dr. John Bliese
Kearney State College
Kearney, Nebraska 68847

Glen Bohke
Clinton Community College
Clinton, Iowa 52732

Louis Bosveld
Mason City Community College
Mason City, Iowa 50401

Dr. Richard Bovjerg
University of Iowa
Iowa City, Iowa 52240

Dale L. Brockmeyer
South Dakota State University
Brookings, S. D. 57001

George G. Brooks
Burlington Community College
Burlington, Iowa 52601

Hamlin L. Brown, Jr.
Marshalltown Community College
Marshalltown, Iowa 50158

Dr. Jack L. Carter
University of Colorado
Boulder, Colorado 80304

Elvin D. Chapman
Fort Dodge Community College
Fort Dodge, Iowa 50501

Dr. John O. Chellevoid
Wartburg College
Waverly, Iowa 52002

Richard W. Coleman
Upper Iowa College
Fayette, Iowa 52142

Dr. Robert Corwin
St. Ambrose College
Davenport, Iowa 52803

Ray Culver
Keokuk Community College
727 Washington
Keokuk, Iowa 52623

Walter E. DeKock
State College of Iowa
Cedar Falls, Iowa 50613

Donald K. DePrenger
North Iowa Area Comm. College
Mason City, Iowa 50401

Marvin S. Davis
North Iowa Area Comm. Colleg
Mason City, Iowa 50401

Sujit Dhar
Ellsworth College
Iowa City, Iowa 50126

Dr. Lee Maria Kleiss
Simpson College
Indianola, Iowa 50125

George Knaphus
Iowa State University
Ames, Iowa 52240

Gerhard F. Koch
Muscatine Community College
Muscatine, Iowa 52761

Sister Mary Jonita Kraus
Ottumwa Heights College
Ottumwa, Iowa 52501

Melvin P. Leimer
Keokuk Community College
Keokuk, Iowa 56203

Harvey Lundy
Estherville Community College, Estherville, Iowa 51334

Jim Mairs
Marshalltown Community High School
Marshalltown, Iowa 50158

Dr. J. W. Maucker, President
State College of Iowa
Cedar Falls, Iowa 50613

Dean May
Iowa Wesleyan College
Mt. Pleasant, Iowa 52641

Dr. Clifford McCollum
State College of Iowa
Cedar Falls, Iowa 50613

Monroe McCoy
Waldorf College
Forest City, Iowa 50436

John William McCurdy
Marshalltown Community College
Marshalltown, Iowa 50158

Emil C. Miller
Luther College
Decorah, Iowa 52101

Robert J. Miller
Estherville Community College
Estherville, Iowa 51334

Dick Millspaugh
Iowa Wesleyan College
Mt. Pleasant, Iowa 52641

William T. Mooney, Jr.
Chairman, Chemistry Conference
El Camino College, Via
Torrance, California 90506

Jean Morrow
Western Illionis University
Macomb, Illinois 61455

Roger Morrow
Western Illinois University
Mccomb, Illinois 61455

J. Fred Moyer
William Penn College
Oskaloosa, Iowa 52577

Dr. Gerald A. Myers
South Dakota State University
Brookings, South Dakota 57007

R. Nellermoe
Waldorf College
Forest City, Iowa 50436

Vernon Ohlendorf
Muscatine Community College
Muscatine, Iowa 52761

Larry W. Oiler
Drake University
Des Moines, Iowa 50311

Sister Columban O'Toole
Briar Cliff College
Sioux City, Iowa 51104

John D. Outten
North Iowa Area Community College, Mason City, Iowa 50401

Thomas Overmire
CUEBS
1717 Massachusetts Ave.,N.W.
Suite 403
Washington, D. C. 20036

John Page
Mason City Community College
Mason City, Iowa 50401

David Parker
Clinton Community College
Clinton, Iowa 52732

William Pecha
Muscatine Community College
Muscatine, Iowa 52761

Margaret L. Peterson
North Iowa Area Community College
Mason City, Iowa 50401

H. V. Peterson
North Iowa Area Community College
Mason City, Iowa 50401

Robert E. Peterson
Mason City Community College
Mason City, Iowa 50401

Dr. Clifford Meints
Simpson College
Indianola, Iowa 50125

Dr. James Divelbliss
Westmar College
LeMars, Iowa 51301

Lester T. Earls
Iowa State University
Ames, Iowa 52240

Sterling Echhardt
Marshalltown Community
College, Marshalltown,
Iowa 50158

Ronald A. Eide
Waldorf College
Forest City, Iowa 50436

Dr. Albert F. Eiss
National Science Teachers
Association - 1201 - 16th.
Street, N. W.
Washington, D. C. 20036

David Elliott
Midwestern College
Denison, Iowa

Gerald Ericson
North Iowa Community College
Mason City, Iowa 50401

Robert Gene Evans
Southwestern Community Col.
Creston, Iowa

David L. Fagle
Marshalltown Community Col.
Marshalltown, Iowa 50158

John Gertenvich
Waldorf College
Forest City, Iowa
50436

Reid Goforth
Iowa Wesleyan College
Mt. Pleasant, Iowa 52641

Elizabeth H. Gooch
Grand View College
Des Moines, Iowa 50316

Miss Patricia Gorman
Clinton Community College
Clinton, Iowa 52732

Delores Graf
Iowa Wesleyan College
Mt. Pleasant, Iowa 52641

B. W. Haglan
Drake University
Des Moines, Iowa 50311

Russell O. Hanson
North Central College
Naperville, Illinois

Ted Harbour
Centerville Community College
Centerville, Iowa 52544

Dr. Richard L. Harbeck
Research Coordinator, Bureau
of Research, Dept. of Health
Education & Welfare
Washington, D. C. 20025

Dr. Delma Harding
Iowa State University
Ames, Iowa 52240

William Hartman
State College of Iowa
Cedar Falls, Iowa 50613

Dr. R. R. Haun
Drake University
Des Moines, Iowa 50311

Martin Hayes
Clinton Community College
Clinton, Iowa 52732

Walter R. Hearn
Iowa State University
Ames, Iowa 52240

Elmer W. Hertel
Wartburg College
Waverly, Iowa 52002

Donald M. Hey
Ellsworth College
Iowa Falls, 50126

Charles Hines
North Iowa Area Community
College
Mason City, Iowa 50401

Sister Mary Claire Hoxmeier
Briar Cliff College
Sioux City, Iowa 51104

George Huedepohl
North Iowa Area Community
College
Mason City, Iowa 50401

Dr. Donald M. Huffman
Central College
Pella, Iowa 50219

Dr. Richard Ikenberry
Kearney State College
Kearney, Nebraska 68847

Marvin P. Jessen
Grand View College
Des Moines, Iowa 50316

Dr. Leland P. Johnson
Drake University
Des Moines, Iowa 50311

J. W. Kercheval
State College of Iowa
Cedar Falls, Iowa 50613

Russell Poel.
North Central College
Naperville, Illinois 60540

R. W. Poulter
Iowa Weslayan College
Mt. Pleasant, Iowa 52641

L. L. Powers
Estherville Junior College
Estherville, Iowa 51334

Lyle Poyzer
Boone Junior College
Boone, Iowa 50036

Rev. Carl S. Rice
St. Ambrose College
Davenport, Iowa 52803

John F. Richards
Ellsworth College
Iowa Falls, Iowa 50126

Thomas Rider
Grand View College
Des Moines 50316

Philip S. Riggs
Drake University
Des Moines, Iowa 50311

James R. Risk
Marion Independent High Sch.
Marion, Iowa

Rodney A. Rogers
Drake University
Des Moines, Iowa 50316

Gerald C. Rowland
Clarinda Community College
Clarinda, Iowa 51632

Dr. Chalmer Roy
Iowa State University
Ames, Iowa 52240

Bill Ryan
Boone Junior College
Boone, Iowa 50036

Silas W. Schirner
University of Iowa
Iowa City, Iowa 52240

Donald J. Schmidt
University of Iowa
Iowa City, Iowa 52240

William Schmidt
Ellsworth College
Iowa Falls, Iowa 50126

G. M. Severson
Waldorf College
Forest City, Iowa 50436

Fae Shawhan
Drake University
Des Moines, Iowa 50311

William R. Shobe
Iowa State University
Ames, Iowa 52240

Andrew Stevenson
Midwestern College
Wichita Falls, Texas 76308

Miss Vivian Strand
Burlington Community College
Burlington, Iowa 52601

Dean C. Stroud
Grand View College
Des Moines, Iowa 50316

Dr. E. Russell TePaske
State College of Iowa
Cedar Falls, Iowa 50613

Ben Thoma
Willmar State Junior College
Willmar, Minnesota 56201

Marie Tucker
North Central College
Naperville, Illinois 60540

Dr. Sherwood Tuttle
University of Iowa
Iowa City, Iowa 52240

Sister Marie Ven Horst
Marycrest College
1607 West 12th. Street
Davenport, Iowa 52804

Dr. Mary Vinje
St. Ambrose College
Davenport, Iowa 52803

Sister Mary Ann Vogel
Ottumwa Heights College
Ottumwa, Iowa 52501

Roger Volker
Webster City Junior College
Webster City, Iowa 50595

James D. Walmsley
Webster City Junior College
Webster City, Iowa 50595

William L. Waltmann
Wartburg College
Waverly, Iowa 52002

Mary Ellen Warters
Grand View College
Des Moines, Iowa 50316

Margaret L. Watson
Simpson College
Indianola, Iowa 50125

Harold Wengert
State College of Iowa
Cedar Falls, Iowa 50613

David West
Ellsworth College
Iowa Falls, Iowa 50126

Kenneth Wilcox
Rehabilitation Institute
Kansas City, Missouri

Russell Wiley
State College of Iowa
Cedar Falls, Iowa 50613

Homer Wilkins
National Science Foundation
Washington, D. C.

Marvin Williams
Kearney State College
Kearney, Nebraska 68847

Dr. Leland Wilson
State College of Iowa
Cedar Falls, Iowa 50613

Edwin Wooten
Centerville Community College
Centerville, Iowa 52544

Dr. Robert Yager
University of Iowa
Iowa City, Iowa 52240